II. *Some Remarks on the Allowances to be made in Aſtronomical Obſervations for the Refraction of the Air. By Dr.* Edm. Halley, R. S. S. *Aſtronomer Royal. With an accurate Table of Refractions.*

WERE the *Medium* of our *Air* much more in Quantity, or the Force of *Gravity* much greater than it is, or in a word, were the Refractive Power of the Air much more ſenſible than we find it, nothing could have been a greater Impediment to Diſcoveries in Aſtronomy: For all Objects appearing by Refraction higher than really they are, till ſuch time as the Laws and Quantity of that Refraction had been aſcertained, it would have been impoſſible to have been ſecure of the true obſerved Place of any Cœleſtial Object. But as it falls out to be ſo little, that none but nice Inſtruments can perceive its Effects, it was not diſcovered to be at all, till *Bernard Walther*'s time, about the Year 1500; nor brought to any ſort of Rule till *Tycho Brahe*; nor aſcertained, till our worthy *Preſident* made the firſt accurate Table thereof: The *Curve* which a Beam of *Light* deſcribes, as it approaches the *Earth*, being one of the moſt perplext and intricate that can well be propoſed, as Dr. *Brook Taylor* in the laſt Propoſition of his *Methodus Incrementorum* has made it evident. By this Table it follows that the *ratio*

of the Sine of the Angle of Incidence to that of the Refracted Angle, encreaſing as the Beam approaches, makes a very notable difference in the place of an Object near the Horizon: but in Objects that are much elevated, the Refractions become ſmall, and their Differences ſcarce exceed a Second *per* Degree; ſo that they are ſufficiently the ſame, as if the Incident and Refracted Angles were on the Surface of a Sphere of Air of the ſame uniform Denſity cloſe adjoyning to the Eye.

When therefore the Stars are twenty degrees or upwards elevated above the Horizon, we may take it for granted, without ſenſible Error, that the Sines of the true and apparent Diſtances from the *Vertex*, are in the ſame conſtant *ratio*. Hence it will appear that the Diſtances of all the Stars are ſeen leſs than they really are, in whatever poſition they are taken, and that not leſs than a Second *per* Degree of the diſtance; that is, a diſtance of 30 degrees, for example, is contracted at leaſt ſo many ſeconds, and one of 60 gr. no leſs than a Minute, if the diſtances be taken by an Inſtrument that is truly divided. So that when Mr. *Hevelius*, to ſhew the exactneſs of his Obſervations, brings eight Diſtances, as taken by his *Sextant*, which exactly compleat the Circle, both in Longitude and Right Aſcenſion; the conſequence is really quite oppoſite to his Deſign: for if thoſe diſtances were the true ones, they being all contracted by appearing through a refracting *Medium*, the Sum of the eight differences of both Longitude and Right Aſcenſion, ought to fall ſhort of a whole Circle or 360 degrees by at leaſt ſix minutes; ſo that I am inclined to believe that the ſixty degrees of Mr. *Hevelius*'s Sextant wanted about a Minute of its true quantity.

Such

Such an allowance as this may perhaps be a proper Expedient to avoid accounting for Refraction in cœleſtial Obſervations, provided the Objects be nearly parallel to the Horizon, or at a good height above it. For all diſtances of Stars are contracted by Refraction, when they are parallel to the Horizon, by the ſame conſtant quantity, be they high or low, that is by about one Second *per* Degree; the Chords of the Arches of the real and viſible diſtances being always in the ſame *ratio* as is the Sine of the Angle of Incidence to that of the refracted Angle.

And this is the caſe wherein the *Refraction* of the *Air* does leaſt affect the diſtances of the *Stars*, which Diſtances are ſtill more and more contracted, as they are nearer to a perpendicular Situation: So that a Diſtance, for Example, of thirty Degrees loſes but half a Minute in a horizontal Site; but if the one Star be 20 degrees high, and the other fifty, it will be leſſened by above three times as much, or by 1 m. 41 ſec. If the one be 30 and the other 60 Degrees high, the ſame diſtance will appear leſs than 30 Degrees by about one Minute; the difference ſtill decreaſing as the Objects are more elevated above the Horizon. But in all caſes to account for the effect of the *Refraction* upon the Diſtances of the Stars, requires, beſides ſome Trigonometrical Work, the help of the afore-mentioned Table, which I here ſubjoyn for the uſe of the Curious, ſuch as I long ſince received it from its Great Author; it having never yet, that I know of, been made publick.

Tabula Refractionum Siderum ad Altitudines apparentes.

Alt. Appar. deg.	m.	Refra-ctio. m.	sec.	Alt. Appar. deg.	Refra-ctio. m.	sec.	Alt. Appar. deg.	Refra-ctio. m.	sec.
0	0	33	45	16	3	4	46	0	52
0	15	30	24	17	2	53	47	0	50
0	30	27	35	18	2	43	48	0	48
0	45	25	11	19	2	34	49	0	47
1	0	23	7	20	2	26	50	0	45
1	15	21	20	21	2	18	51	0	44
1	30	19	46	22	2	11	52	0	42
1	45	18	22	23	2	5	53	0	40
2	0	17	8	24	1	59	54	0	39
2	30	15	2	25	1	54	55	0	38
3	0	13	20	26	1	49	56	0	36
3	30	11	57	27	1	44	57	0	35
4	0	10	48	28	1	40	58	0	34
4	30	9	50	29	1	36	59	0	32
5	0	9	2	30	1	32	60	0	31
5	30	8	21	31	1	28	61	0	30
6	0	7	45	32	1	25	62	0	28
6	30	7	14	33	1	22	63	0	27
7	0	6	47	34	1	19	64	0	26
7	30	6	22	35	1	16	65	0	25
8	0	6	0	36	1	13	66	0	24
8	30	5	40	37	1	11	67	0	23
9	0	5	22	38	1	8	68	0	22
9	30	5	6	39	1	6	69	0	21
10	0	4	52	40	1	4	70	0	20
11	0	4	27	41	1	2	71	0	19
12	0	4	5	42	1	0	72	0	18
13	0	3	47	43	0	58	73	0	17
14	0	3	31	44	0	56	74	0	16
15	0	3	17	45	0	54	75	0	15